Index

Numerics

10BASE2, 22
10BASE5, 22
10BASE-T, 22
802.11. *See* IEEE 802.11
802.11a, 788-789
802.11b, 789-790
802.11g, 790-791
802.11n, 791
802.1D Spanning Tree Protocol. *See* STP
802.1Q
    PVST+, 69
    VLAN trunking, 44-45
        configuration, 45-46
802.1Q-in-Q tunneling, 51-52
802.1X, 764-766
    configuration, 766
802.2 LLC, Type fields, 18

A

AAA (authentication, authorization, and accounting), 747
    authentication methods, 748-750
    CLI, 747
    groups of AAA servers, 750-751
    overriding defaults for login security, 751
aaa authentication command, 749-750
aaa authentication ppp default, 752
ABRs (Area Border Routers), 276
    stubby areas, 287
access lists, statements, 771
access points, 795, 832
access ports, protecting, 82-83
ACEs (Access Control Entries), 770
    IP ACL, 770-771
ACK flags, 156
ACKs, 799
ACL, rate-limit ACL, 580
ACS (Cisco Secure Access Control Server), 747
active and not pruned VLANs, 48
active mode, FTP, 161-162
active routes (EIGRP), 243-245
    stuck-in-active state, 245-246
active scanning, infrastructure mode, 799
AD (administrative distance), 317, 323-324
    preventing suboptimal routes, 335-338
        with route tags, 338-340
ad hoc mode, 800-801
    wireless LANs, 794
adapters, wireless LAN client adapters, 833
adaptive shaping, 565
    FRTS, 570
adaptive shaping, Frame Relay, 614
adding
    default routes to BGP, 381-382
    eBGP routes to IP routing tables, 392-393

iBGP routes to IP routing tables, 394-409
multiple BGP routes to IP routing tables, 450
address formats, Ethernet, 17-18
Address Resolution Protocol. *See* ARP
addresses
Ethernet, 16-17
unicast addresses, 16
inappropriate IP addresses, 774-775
IP. *See* IP addresses
MAC addresses
mapping to multicast IP addresses, 642-643
overriding, 18
tables, displaying, 53, 86, 197, 778
multicast IP addresses. *See* multicast IP addresses
adjacencies, EIGRP, 233-236
adjacency tables, 179
ARP and inverse ARP, 179-180
adjacent-layer interaction, 857
administration, SNMP, 164
administrative distance. *See* AD
administrative scoping, 690
administrative weight, 456-457
advertising BGP routes to neighbors, 383
BGP Update message, 383-384
determining contents of updates, 384-386
impact of decision process and NEXT_HOP, 386-391
AES (Advanced Encryption Standard), 810, 812
aggregatable global unicast addresses, 120-121
aggregate-address command, 378-379, 423, 462
BGP route summarization, 429-430
aggregate-address suppress-map command, 429
AID (association identifier), 799
Air/RF scanning and monitoring, CiscoWorks WLSE, 836
AIS (Alarm Indication Signal), 594
alarms, T1, 594
allocation of subnets, 105-106
allow-default keyword, 774
allowed and active VLANs, 48
allowed VLANs, 48
AMI (Alternate Mark Inversion), 592
versus B8ZS, 593
amplitude, 815
antenna diversity, 821
antennas, 795-796
Anycast RP with MSDP, 726-727
area authentication, 301
OSPF, 303
Area Border Routers (ABRs), 276
area filter-list, 298
area range command, 299
area stub command, 288
area virtual-link command, 303

ARP (Address Resolution Protocol), 137-139, 179-180
DAI, 758
gratuitous ARPs, 759
AS_CONFED_SEQ, 399, 439, 442
AS_CONFED_SEQ the show ip bgp command., 445
AS_PATH, 448
shortest AS_PATH, 459-460
prepending and route aggregation, 461-463
removing private ASNs, 460
AS_PATH filters, matching AS_PATHs, 436-439
AS_PATH PA, 446
AS_PATH segment types, 431-433
AS_PATHS, 360
AS_SET and AS_CONFED_SEQ, 445
filtering BGP updates, 430-431
AS_PATH filters, 436-439
AS_SET and AS_CONFED_SEQ, 439, 442, 445
BGP AS_PATH and AS_PATH segment types, 431-433
regular expressions, 433-434
and manual summaries, BGP tables, 378-381
AS_SEQ, 378
AS_SET, 439, 442, 445
ASBRs (Autonomous System Boundary Routers), 276
ASNs (autonomous system numbers), 360, 432, 459, 640
removing private ASNs, 460-461
Ass, 399
multiple adjacent AS, 466
single adjacent AS, 465
assert messages, PIM, 703-704
as-set option, 379
assigning interfaces to VLANs, 35
assisted site surveys, CiscoWorks WLSE, 835
association identifier (AID), 799
Assured Forwarding (AF) PHBs, 491-492
attenuation, RF signals, 816
authentication
configuring OSPF, 301-303
EIGRP, 250
RIP, 216-219
TCP/IP, 163
authentication methods, 748-750
authentication, authorization, and accounting. *See* AAA
auto-cost reference-bandwidth, 294
automatic access point configuration, CiscoWorks WLSE, 834
automatic medium-dependent interface (Auto-MDIX), 9
Auto-MDIX (automatic medium-dependent interface crossover), 9
auto-negotiation, Ethernet, 9
Autonomous System Boundary Routers (ASBRs), 276
autonomous system numbers. *See* ASNs
autonomous system path. *See* AS_PATHs
Auto-RP, 721-723
autosummarization
EIGRP, 250
RIP, 214-216
auto-summary, impact on redistributed routes and network command, 375-377
auto-summary command, 378
aux, 751

B

B8ZS (Bipolar 8 Zero Substitution), 592
versus AMI, 593
BackboneFast, optimizing STP, 73, 75
backdoor routes, IP routing tables, 393-394
Backward Explicit Congestion Notification (BECN), 559, 614
bandwidth, 815
CBWFQ, limiting, 532-534
LLQ, 537
bandwidth command, 529, 532, 564
bandwidth percent, configuring shaping, 564
bandwidth percent command, 533
bandwidth remaining percent command, 533
basic service set (BSS), 792
Bc (committed burst), 556
CB Policing defaults, 577
Be (excess burst size), 556
CB Policing defaults, 577
traffic shaping, 557
beamwidth, 797
BECN (Backward Explicit Congestion Notification), 559, 614
Frame Relay congestion, 614
BGP (Border Gateway Protocol), 276
advertising routes to neighbors, 383
BGP Update message, 383-384
determining contest of updates, 384-386
impact of decision process and NEXT_HOP, 386-391
AS_PATHs, 360
command references, 411, 479
filtering updates based on NLRI, 424-427
route maps, 427
soft reconfiguration, 428
maximum-paths command, 471-472
PAs, 360, 410
route maps, match and set commands, 479
subcommands for confederations, 402
bgp always-compare-med, 466
BGP AS_PATH, 431-433
BGP COMMUNITY PA, 472-474
filtering NLRI using COMMUNITY values, 479
matching with community lists, 474-475
removing COMMUNITY values, 475-476, 479
bgp confederation identifier command, 401
BGP decision process, 446-448
adding multiple BGP routes to IP routing tables, 450
BGP PAs, 453-454, 456
mnemonics for memorizing, 450, 452
tiebreakers, 448-450
maximum-paths command, 467
bgp deterministic-med command, 466
BGP filtering tools, 417, 423-424
BGP message types, 368-369
BGP metric, 464
BGP neighbor states, 368
resetting peer connections, 369-370
BGP neighbors, 361-362
checks before becoming neighbors, 366-368
eBGP, 365-366
iBGP, 362-365
BGP Open messages, 361
BGP PAs, 446
BGP decision process, 453-454, 456
BGP path attributes BGP path attributes, 446
BGP policies, configuring, 452
Step 0 NEXT_HOP reachable, 456
Step 1 Administrative weight, 456-457

Step 2 Highest Local Preference (LOCAL_PREF), 457-458
Step 3 Choose Between Locally Injected Routes Based on, 458
Step 4 Shortest AS_PATH, 459-463
Step 5 Best ORIGIN PA, 463
Step 6 Smallest Multi-Exit Discriminator, 464
Step 7 Prefer Neighbor Type eBGP over iBGP, 466
Step 8 Smallest IGP Metric to the NEXT_HOP, 466
Step 9 Lowest BGP Router ID of Advertising Router, 467
Step 10 Lowest Neighbor ID, 467, 469
BGP prefixes, 370
BGP route summarization, aggregate-address command, 429-430
BGP router ID of advertising router, 467
BGP routes, 370
BGP Routing Information Base (RIB), 370
BGP routing policies, 417

BGP synchronization, 395-398
disabling, 398
BGP tables, 370
injecting routes/prefixes, 370
impact of auto-summary on redistributed routes and, 375-377
network command, 370-371, 373
redistributing from IGP, static or connected routes, 373-375
manual summaries and AS_PATH, 378-381
routes
adding default routes, 381-382
ORIGIN, 382-383
BGP Update messages, 361
advertising BGP routes to neighbors, 383-384
determining contents of updates, 384-386
impact of decision process and NEXT_HOP, 386-391
BGP updates
filtering by matching AS_PATHS, 430-431
AS_PATH filters, 436-439
AS_SET and AS_CONFED_SEQ, 439, 442
BGP AS_PATH and AS_PATH segment, 431-433
regular expressions, 433-434
rules for routes, 392
bidirectional PIM, 729-730
binary method
exclusive summary routes, 110
inclusive summary routes, 108-109
subnet numbers, broadcast addresses, range of IP addresses, determining, 98-99, 102-104
binary phase shift (BPSK), 818
binary values, converting to decimal and hexadecimal values, 955, 959
Bipolar 8 Zero Substitution (B8ZS), 592
Bipolar Violations (BPVs), 593
blocking transitioning to forwarding, STP, 67-68
blocking state, 61
Spanning Tree, 68
bogons, 774
boot fields, 859
boot sequences, IOS software, 858-859
boot system command, IOS, 859
boot system flash, 859
boot system ROM, 859
boot system tftp, 860

BOOTP, 139-141
BootStrap Router (BSR), 721
Border Gateway Protocol (BGP), 276
BPDU (bridge protocol data unit), 62, 70
BPDU Guard, 82-83
enabling, 754
BPSK (binary phase shift), 818
BPVs (Bipolar Violations), 593
bridge protocol data unit (BPDU), 62
bridges, 797
wireless and workgroup bridges, 833
broadcast addresses, 16, 43
determining
binary method, 98-99
decimal method, 99-101
broadcast clients (NTP), 144
broadcast domains, 31
broadcast methods, 633
broadcast subnets, 98
BSR (BootStrap Router), 721, 724-725
BSS (basic service set), 792
buckets, refilling dual token buckets, 573
burst size, 509

C

C&M tools. *See* classification and marking tools
cabling, UTP cabling, 24
cabling standards, Ethernet, 24
calculating
metrics for types 1 and 2, 285-286
SN, 525
STP costs to determine RPs, 63
CAM (Content Addressable Memory), 66, 643
updating, 66-67
CAR (committed access rate), 551
CB Policing, 579-581
carrier detects, synchronous serial links, 594-595
carrier sense multiple access with collision avoidance (CSMA/CA), 809
Carrier Sense Multiple Access with Collision Detection (CSMA/CD), 10
carrier transitions, 595
catalyst IOS commands for catalyst switch configuration, 23
Category 5 wiring, 8-9
CatOS, 38
CB Marking tool, 500-505
CoS and DSCP, 505-507
locations for marking, 508-509
NBAR, 507-508
CB Policing (Class-Based Policing), 551, 571
CAR, 579-581
command references, 584
configuring, 575
defaults for Bc and Be, 577
dual-rate policing, 577-578
multi-action policing, 578
policing by percentage, 578-579
policing subsets of traffic, 576-577
single-rate, three-color policing, 575-576
single-rate, three-color policing, 573
single-rate, two-color policing, 571-572
two-rate, three-color policing, 573-575
CB Shaping (Class-Based Shaping), 551
command references, 582
configuring, 559-561
to peak rates, 565
CBT (Core-Based Tree), 687
CBWFQ (class-based WFQ), 521, 529-530, 532, 538
bandwidth, 532-534
command references, 530
features of, 529

CCM (Cisco CallManager), 839
CCP (Compression Control Protocol), 602
CDP, disabling, 754
CDT (congestive discard threshold), 526
ceased updates (RIP), 210-212
CEF (Cisco Express Forwarding), 178
adjacency tables, ARP and inverse ARP, 179-180
FIB, 178
Cell Loss Priority (CLP) bit, 493
centralized firmware updates, CiscoWorks WLSE, 835
CGMP (Cisco Group Management Protocol), 635, 663-666, 668
join message process, 666
leave message, 667
messages, 668
change notification, STP topology, 66-67
channels
nonoverlapping channels, 802.11g, 790
RF channels, 803-804
characteristics of RF signals, 815-816
Checksum, 160
CIDR (classless interdomain routing), 111-112
CIR (committed information rate), 556
Cisco 2000 Series Wireless LAN Controller, 833
Cisco 2950 switches versus Cisco 3550 switches, 547-548
Cisco 3550, queuing, 545-546
Cisco 3550 switches, 543-545
versus Cisco 2950 switches, 547-548
Cisco 4100 Series Wireless LAN Controller, 833
Cisco Aironet 1100 Series, 832
Cisco Aironet 1130AG Series, 832
Cisco Aironet 1200 Series, 832
Cisco Aironet 1230AG Series, 832
Cisco Aironet 1300 Series, 832
Cisco Aironet 1300 Series Outdoor Access Point/Bridge, 833
Cisco Aironet 1400 Series Wireless Bridge, 833
Cisco Aironet 350 Series, 833
Cisco Aironet 350 Wireless LAN Client Adapter, 833
Cisco Aironet 5-GHz 54-Mbps Wireless LAN Client Adapter (CB20A), 833
Cisco Aironet 802.11a/b/g PCI Adapter, 833
Cisco Aironet 802.11a/b/g Wireless CardBus Adapter, 833
Cisco CallManager (CCM), 839
Cisco Express Forwarding (CEF), 178
Cisco Group Management Protocol. ***See*** **CGMP**
Cisco SAFE Blueprint, Layer 3 security, 768
Cisco SAFE Blueprint document, 752
Cisco. Secure Access Control Server (ACS), 747
CiscoWorks WLSE (Wireless LAN Solution Engine), 834
air/RF scanning and monitoring, 836
assisted site surveys, 835
automatic access point, 834
centralized firmware updates, 835
customizable thresholds, 835
dynamic grouping, 835
fault status, 836
IDS, 836
secure user interfaces, 836
security policy monitoring, 836
self-healing functions, 837
SSIDs, 835
troubleshooting, 837
VLAN configuration, 835
class maps, MQC classification with, 497-499

Class of Service (CoS) field, 493
Class Selector (CS) PHBs, 491
Class-Based Marking. *See* CB Marking tool
Class-Based Policing. *See* CB Policing
Class-Based Shaping. *See* CB Shaping
class-based WFQ. *See* CBWFQ
class-default queues, 529
classful compared to classless, 227
classful IP addressing, 94-95
subnets, 95-96
classful routing, 185-186
classification and marking tools, 485
CB Marking, 500-505
CoS and DSCP, 505-507
locations for marking, 508-509
NBAR, 507-508
CoS (Class of Service) field, 493
drop probability bits, 493
DSCP (Differentiated Services Code Point) field, 490-493
field locations, 494-495
IP Precedence (IPP) field, 489-490
MPLS Experimental (EXP) field, 494
MQC (Modular QoS CLI), 495-496
class maps, 497-499
match commands, 511-512
NBAR, 499-500
policers, 509-510
policy routing, 510
classless compared to classful, 227
classless interdomain routing (CIDR), 111-112
classless IP addressing, 94, 97
classless routing, 185-186
class-map command (MQC), 496
clear command, 370, 423
clear ip cgmp, 668
clearing
IP routing tables, EIGRP, 250
OSPF processes, 292-295
CLI
AAA, 747
passwords, 745-746
enable and username passwords, 746-747
CLI help features, 860-861
client hardware address, DHCP, 762
client mode (NTP), 143
client tracking, 828
code bits, TCP, 156
collision domains, Ethernet, 10-11
command references
BGP, 411, 479
CB Marking tool, 501
CB Policing, 584
CB Shaping, 582
CBWFQ, 530
EIGRP, 251-252
Frame Relay, 623
FRTS, 583
IP addresses, 126
IP ACL, 769
IP forwarding, 197
IP multicast routing, 732
match commands (MQC), 511-512
OSPF, 305-307
packet routing, 146-148
redistribution, 352
RIP, 225-226
STP, 86
synchronous serial links, 604
WFQ, 527
commands
aaa authentication, 749-750
aaa authentication ppp default, 752
aggregate-address, 378-379, 423, 462
BGP route summarization, 429-430
aggregate-address suppress-map, 429
area authentication, 301
OSPF, 303

area filter-list, 298
area range command, 299
area stub, 288
area virtual-link, 303
auto-cost reference-bandwidth, 294
auto-summary, 378
bandwidth, 529, 532, 564
bandwidth percent, 533
bandwidth remaining percent, 533
bgp always-compare-med, 466
bgp confederation identifier, 401
bgp deterministic-med, 466
boot system, 859
boot system flash, 859
boot system ROM, 859
boot system tftp, 860
clear, 370, 423
clear ip cgmp, 668
compress, 602
debug ip arp, 196
debug ip ospf adjacency, 301
debug ip policy, 195
debug policy, 196
default-information originate, 348-349, 382
DHCP snooping, 763
distance, 324, 394
distance router, 337
distribute-list command, 295-297
do, 182
enable, 745
enable password, 746
enable secret, 746
encapsulation, 50
encapsulation ppp, 597
fair-queue, 527
frame-relay class, 566
frame-relay fragment, 621
frame-relay fragment size, 621
frame-relay interface-dlci, 566, 615-616
frame-relay map, 183-184, 615-616
frame-relay mincir rate, 570
hold-queue, 527
hold-queue x out, 521
IOS, 862
ip access-group, 769
ip bgp-community new-format, 474
ip cef global configuration, 179
ip classless, 186, 345
ip community-list, 474, 479
ip default-network, 349-350
ip multicast-routing, 692, 708
ip ospf area, 295
ip ospf authentication, 301
ip ospf cost, 50, 293-294
ip ospf network, 269
ip pim dense-mode, 692
ip pim rp-address, 720
ip pim sparse-mode, 708
ip pim spt-threshold, 717
ip policy, 192
ip proxy-arp, 196
ip summary-address rip, 345
ip verify source command, 764
keyboard commands, 861
log-adjacency-changes detail, 292
login authentication, 751
map-class frame-relay, 566
map-class shape-with-LLQ, 620
match, 319-320
match as-path list-number, 439
match ip address, 192
match length, 192
maximum-paths, 450, 470, 472
    BGP decision process tiebreakers, 466-467
max-metric router-lsa on-startup announce-time, 304
max-metric router-lsa on-startup wait-for-bgp, 304
max-reserved-bandwidth, 532

neighbor, 270, 274, 468
neighbor default-originate, 382
neighbor ebgp-multihop, 401, 469
neighbor filter-list command, 439
neighbor peer-group, 365
neighbor remote-as, 365-366
neighbor route-map, 439
neighbor shutdown, 370
neighbor weight, 456
network, 295
injecting prefixes/routes into BGP tables, 370-371, 373
network backdoor, 394
no auto-summary, 370
no frame-relay inverse-arp, 184
no ip classless, 186, 345
no ip directed-broadcast, 773
no ip route-cache cef, 179
no synchronization, 395
no terminal editing, 861
ospf auto-cost reference-bandwidth, 294
password, 745
police, 575, 578
police commands, 577
policy-map queue-voip, 563
port security configuration, 755
ppp authentication, 752
ppp multilink fragment-delay, 601
ppp multilink interleave, 600
prefix-list, BGP, 425
prefix-list commands, 322
priority, 535
priority-queue out, 543
radius-server host, 750
rate-limit, 579
recalling, 861
redistribute, 321
redistribute command, 324-325
redistribute connected, 458
redistribute ospf, 328
redistribute static, 347-348
route-map, 317-319
BGP, 425
router bgp, 365, 401
service password encryption, 746
service password-encryption, 303, 747
service-policy, 532
service-policy out, 538
service-policy output, 532, 559
service-policy output policy-map-name, 564
set, 320
set as-path prepend command, 461
set community none, 476
set fr-de, 615
shape, 559, 561
shape average, 565
shape fecn-adapt, 614
shape peak mean-rate, 565
shape percent, 564
show interface trunk command, 48
show interfaces, 595
show ip, 23
show ip arp, 195
show ip bgp, 382, 439, 453-455
show ip bgp neighbor advertised-routes, 388
show ip bgp neighbor neighbor-id advertised routes, 439
show ip bgp neighbor neighbor-id received routes, 439
show ip bgp regexp expression, 439
show ip mroute, 692, 714
show ip ospf border-routers, 283
show ip ospf database, 281
show ip ospf database summary link-id, 283
show ip ospf neighbor, 262
show ip ospf statistics, 283
show ip route, 290
show queue, 528

spanning-tree portfast, 79
spanning-tree vlan, 73
summary-address, 344
switchport access vlan, 38, 43
switchport mode, 49
switchport nonegotiate, 49
switchport port-security maximum, 756
switchport trunk allowed, 48
switchport trunk encapsulation, 49
tacacs-server host, 750
terminal editing, 861
terminal history size, 860
traffic-shape fecn-adapt, 614
traffic-rate, FRTS configuration, 567-568
username password, 747
username, 748
wrr-queue dscp-map, 546
wrr-queue random detect, 546
committed access rate. *See* CAR
committed burst (Bc), 556
committed information rate (CIR), 556
Common Spanning Tree (CST), 69
community lists, matching with COMMUNITY, 474-475
COMMUNITY PA, BGP, 473-474
filtering NLRI using COMMUNITY values, 479
matching with community lists, 474-475
removing COMMUNITY values, 475, 479
community VLANs, 37
comparing
802.11 standards, 791
BGP, prefix lists, distribute lists, and route maps, 428-429
Cisco 3550 and 2950 switches, 547-548
IGMP versions, 661
queuing tools, 520
wireless security, 813
compatibility, trunk configuration compatibility, 48-49
compress command, 602
compression
Frame Relay payload compression, 619-620
PPP, 601-602
header compression, 602-603
layer 2 payload compression, 602
Compression Control Protocol (CCP), 602
confederation eBGP peers, 399
confederations
BGP subcommands, 402
IP routing tables, 399-401
configuring, 401-404
configuration
CB Marking tool, 500-505
CoS and DSCP, 505-507
locations for marking, 508-509
NBAR, 507-508
EIGRP, 246-249
LCP, 597-598
MQC (Modular QoS CLI), 495-496
class maps, 497-499
NBAR, 499-500
RIP, 213-214
authentication, 216-219
autosummarization, 214-216
distribution list and prefix list filtering, 222-224
next-hop and split horizon features, 219-220
offset lists, 220-222
static configuration of Frame Relay mapping, 183-184
trunks, 53, 779
configuration mode
creating VLANs, 35-36
putting interfaces into VLANs, 34-35

configuration register, 858-859
configurations, switch ports, 12-14
configuring
BGP policies. *See* BGP policies, configuring
CB Policing, 575
defaults for Bc and Be, 577
dual-rate policing, 577-578
multi-action policing, 578
policing by percentage, 578-579
policing subsets of traffic, 576-577
single-rate, three-color policing, 575-576
CB Shaping, 559-561
confederations, IP routing tables, 401-404
Frame Relay, 615-619
FRTS, 565-567
adaptive shaping, 570
setting parameters, 568-569
traffic-rate command, 567-568
with LLQ, 569-570
MED
multiple adjacent AS, 465-466
single adjacent AS, 465
MLS, 188-191
MST, 81
OSPF, 290-292
alternatives to OSPF network command, 295
authentication, 301-303
costs, 292-295
stub router, 303-304
virtual links, 299-301
PortChannels, 77-78
RADIUS server groups, 750
route maps with route-map command, 317-319
shaping by bandwidth percent, 564
STP, 70-73
TCP intercept, 777
VLAN trunking on routers, 49-51
VLANs, 31
storing, 43-44
VLAN database configuration mode, 32-34
VTP, 40-41
extended-range VLANs, 42
normal-range VLANs, 42
WFQ, 527-528
WRED, 542
conforming packets, 571
congestion, Frame Relay, 613
adaptive shaping, FECN, and BECN, 614
DE big, 615
congestion management. *See* queuing
congestion window (CWND), 158
congestive discard threshold (CDT), 526
connecting with networks, infrastructure mode, 799
connections, TCP, 155-156
console, 751
Content Addressable Memory (CAM), 66, 643
convergence
EIGRP, 240-241
going active on routes, 243-245
input events and local computation, 241-243
limiting query scope, 246
stuck-in-active state, 245-246
RIP, 205-206
ceased updates, 210-212
steady-state operation, 206-208
triggered updates and poisoned routes, 208-210
tuning, 212-213
converging to STP topology, 65-66

conversion, decimal-to-hexadecimal-to-binary values, 955, 959
Core-Based Tree (CBT), 687
CoS (Class of Service) field, 493
CB Marking tool, 505-507
CQ (custom queuing), 523-524
cross-over cables, 9
CSMA/CA (carrier sense multiple access with collision avoidance), 809
CST (Common Spanning Tree), 69
CSU/DSU, 594
custom queuing (CQ), 523-524
customizable thresholds, CiscoWorks WLSE, 835
cut-through, switches, 23
CWND (congestion window), 158

D

D4, 592
DAI (dynamic ARP inspection, 758-761
data communications equipment (DCE), 594
data definition, SNMP, 164
Data Link Connection Identifier (DLCI), 610-611
data rates, wireless configuration parameters (IEEE 802.11), 804-805
data terminal equipment (DTE), 594
data transfers, infrastructure mode, 799-800
Database Description (DD or DBD), 264
databases, OSPF. *See* OSPF database exchange
DBD (Database Description), 264
DCE (data communications equipment), 594
DCF (distributed coordination function), 809-810
DD (Database Description), 264
DD messages, flooding LSA headers to neighbors, 264
DE (Discard Eligibility) bit, 615
Dead, 308
debug ip arp, 196
debug ip ospf adjacency, 301
debug ip policy command, 195
debug policy, 196
decimal method
inclusive summary routes, 109-110
subnet numbers, broadcast addresses, range of IP addresses determining, 99-101, 104-105
decimal values, converting to hexadecimal and binary values, 955, 959
deep packet inspection, 499
Deering, Dr. Steve, 632
default routes, 345-346
adding to BGP, 381-382
creating using route summarization, 350-351
default-information originate command, 348-349
ip default-network command, 349-350
default-information originate command, 348-349, 382
dense mode, multicast forwarding, 6 84-685
dense-mode routing protocols, 690
DVMRP, 706
MOSPF, 706
PIM-DM, 691
forming adjacencies with PIM hello messages, 691
Graft messages, 700-702
Prune messages, 693-695
reacting to failed links, 695-697

rules for pruning, 697-699
source-based distribution trees, 692-693
steady-state operation and state refresh messages, 699-700
deny clauses, route maps, 333
designated routers. *See* DR
designated port (DP), 65
determining, 64-65
designated routers, PIM, 704
designated switches, 64
DHCP, 139-141
DHCP snooping, 761-762
commands, 763
DHCP snooping binding table, 761
Differentiated Services Code Point (DSCP) field, 490-493
DiffServ, RFCs, 512
Diffusing Update Algorithm (DUAL), 245
Digital Signal Level 0 (DS0), 592
direct sequence spread spectrum (DSSS), 788
directed broadcasts, 772-774
disabling
BGP synchronization, 398
CDP and DTP, 754
InARP, 184-185
discard categories, WRED, 539
Discard Eligibility (DE) bit, 493, 615
discarding logic, 540
discovering neighbors, hello messages, 263-264
discretionary PAs, 446
discriminators, multi-exit discriminators, 464
distance command, 324, 394
preventing suboptimal routes, 336
distance router command, 337
Distance Vector Multicast Routing Protocol (DVMRP), 635, 687, 706
distribute lists versus prefix lists and route maps (BGP), 428-429
distributed coordination function (DCF), 809
distribute-list command, 295-297
distribution list filtering, RIP, 222-224
DIX, Type fields, 18
DIX Ethernet Version 2, 22
DLCI (Data Link Connection Identifier), 610-611
do command, 182
domains, broadcast domains, 31
downstream routers, 697
DP (designated port), 65
DR (designated routers)
on LANs, 266
election, 268-269
optimizing, 266-268
on WANs, 269
OSPF network types, 269
drop probability bits, 493
DS0 (Digital Signal Level 0), 592
DSCP (Differentiated Services Code Point) field, 490-493
CB Marking tool, 505-507
DSCP-based WRED, 541
DSSS (direct sequence spread spectrum), 788, 818
DTE (data terminal equipment), 594
DTP (Dynamic Trunk Protocol), 45
disabling, 754
DUAL (Diffusing Update Algorithm), 245
dual stacks, IPv6 configuration, 121-123
dual-rate policing, CB Policing configuration, 577-578
duplex, Ethernet, 9
DVMRP (Distance Vector Multicast Routing Protocol), 635, 687, 706
dynamic ARP inspection (DAI), 758-761

dynamic grouping, CiscoWorks WLSE, 835
dynamic NAT, configuration, 118-119
dynamic NAT (without PAT), 116-117
Dynamic Trunk Protocol (DTP), 45

E

E1, 592 versus T1, 593
EAP (Extensible Authentication Protocol), 764
802.1X, 764-766
EAPoL (EAP over LAN), 764
eBGP (external BGP), 362, 365-366
over iBGP, 466
eBGP routes, adding to IP routing tables, 392-393
egress blocking, 555, 613
egress queuing, Cisco 3550 switches, 543-545
EIGRP, 233
adjacencies, 233-236
authentication, 250
autosummarization, 250
clearing IP routing tables, 250
command reference, 251-252
configuration, 246-249
convergence, 240-241
going active on routes, 243-245
input events and local computation, 241-243
limiting query scope, 246
stuck-in-active state, 245-246
IS-IS configuration for creating default summary routes, 351
load balancing, 249
offset lists, 250
packet types, 252
route filtering, 250
split horizon, 250
static routes, redistribute static, 347
topology table, 238-240
updates, 236-238
EIGRP route summarization, 344
electing root switches, STP, 61-63
election, DR election on LANs, 268-269
enable command, 745
enable password command, 746
enable secret command, 746
enabling Root Guard and BPDU Guard, 754
encapsulation, Frame Relay, 612-613
encapsulation command, 50
encapsulation ppp command, 597
encrypted enable passwords, 748
enterprises, applying wireless LANs, 837
security, 837-838
voice services, 839
EoMPLS (Ethernet over MPLS), 51
error recovery, TCP, 157
ESF (Extended Superframe), 592
established keyword, 771
ACL, 776
Ethernet
address formats, 17-18
addresses, 16-17
unicast addresses, 16
auto-negotiation, 9
cabling standards, 24
Category 5 wiring, 8-9
collision domains, 10-11
cross-over cables, 9
CSMA/CD, 10
duplex, 9
frames, 14
framing and addressing, 14
header fields, 15
multicast Ethernet frames, 16
packets, 14
RJ-45 pinouts, 8-9
speed, 9

switch buffering, 10-11
switch port configuration, 12-14
twisted pairs, 8-9
Type fields, 18
types, 24
types of Ethernet, 22
VLANs. *See* VLANs
Ethernet over MPLS (EoMPLS), 51
EUI-64 format, 121
exceeding packets, 571
excess burst size (Be), 556
exclusive summary routes, 108
binary method, 110
Expedited Forwarding (EF) PHBs, 492-493
Extended Superframe (ESF), 592
extended-range VLANs, 42
Extensible Authentication Protocol. *See* EAP
external BGP. *See* eBGP

F

failed links, reacting to (PIM-DM), 695-697
fair-queue command, 527
Fast Link Pulses (FLP), 9
Fast Secure Roaming (FSR), 828
fast switching, IP forwarding, 178
FastE, 22
fast-switching cache, 178
fault status, CiscoWorks WLSE, 836
FCC rules, RF signals, 819
FCS (frame check sequence), 177
FD (feasible distance), 240
FDX (full duplex), 9
feasibility conditions, 241
feasible distance (FD), 240
FECN (Forward Explicit Congestion Notification), 614
FHSS (frequency hopping spread spectrum), 788, 817
FIB (Forwarding Information Base), 178
fields
classification and marking tools
Cell Loss Priority (CLP) field, 493
Class of Service (CoS) field, 493
Differentiated Services Code Point (DSCP) field, 490-493
Discard Eligibility (DE) field, 493
IP Precedence (IPP) field, 489-490
locations of, 494-495
MPLS Experimental (EXP) field, 494
Type fields, 18

FIFO (first-in, first-out), 519
FIFO queuing, 521
filtering
BGP filtering tools. *See* BGP filtering tools
BGP updates by matching AS_PATHs, 430-431
BGP updates based on NLRI, 424-427
route maps, 427
soft reconfiguration, 428
BGP updates by matching AS_PATHs
AS_PATH filters, 436-439
AS_SET and AS_CONFED_SEQ, 439, 442
BGP AS_PATH and AS_PATH segment, 431-433
regular expressions, 433-434
distribution list and prefix list filtering (RIP), 222-224
NLRI, using COMMUNITY values, 479

OSPF, 295
ABR LSA type 3 filtering, 297-298
distribute-list command, 295-297
subnets of summaries, using aggregate-address command, 429-430
finding RPs, 720, 728
Anycast RP with MSDP, 726-727
Auto-RP, 721-723
BSR, 724-725
finish time (FT), 525
flags
mroute, 735
TCP, 156
flood (pacing), 309
flooding LSA headers to neighbors, 264
flow, 524
FLP (Fast Link Pulses), 9
ForeSight, 559
Forward Explicit Congestion Notification (FECN), 614
forwarding, transitioning from blocking (STP), 67-68
Forwarding Information Base (FIB), 178
Forwarding state (Spanning Tree), 68
fraggle attacks, 774
fragmentation
Frame Relay, 621-622
wireless configuration parameters, IEEE 802.11, 808
fragment-free, switches, 23
frame check sequence (FCS), 177
Frame Relay, 610
command references, 623
configuring, 615-619
congestion, 613
adaptive shaping, FECN, and BECN, 614
DE bit, 615
DLCI, 610-611
fragmentation, 621-622
headers and encapsulation, 612-613
LMI, 611-612
payload compression, 619-620
traffic shaping, 559
Frame Relay Forum (FRF), 610
Frame Relay Forum Implementation Agreement 9 (FRF.9), 619
Frame Relay Inverse ARP, 180-183
disabling, 184-185
Frame Relay Inverse ARP (InARP), 180-183
Frame Relay mapping, static configuration, 183-184
Frame Relay Traffic Shaping. *See* FRTS
frame-relay class, 566
frame-relay fragment command, 621
frame-relay fragment size command, 621
frame-relay interface-dlci, 566, 615-616
frame-relay map, 615-616
frame-relay map commands, 183-184
frame-relay mincir rate command, 570
frames
Ethernet, 14
multicast Ethernet frames, 16
framing T1, 592-593
frequency hopping spread spectrum (FHSS), 788
frequency spectrum, 815
FRF (Frame Relay Forum), 610
FRF.12, 622
FRF.9 (Frame Relay Forum Implementation Agreement 9), 619
FRTS (Frame Relay Traffic Shaping), 551, 565
command references, 583
configuring, 565-567
adaptive shaping, 570
setting parameters, 568-569
with LLQ, 569-570
with traffic-rate command, 567-568

FSR (Fast Secure Roaming), 828
FT (finish time), 525
FTP (file transfer protocol), active and passive mode, 161-162
full duplex (FDX), 9
full-featured IOS, 858
functions of CBWFQ, 529

G–H

gain, RF signals, 816
gang of four, 610
GDA (Group Destination Address), 664
GigE, 22
GLBP (Gateway Load Balancing Protocol), 141-143
global addresses, 120-121
global addressing, 611
GlOP, 640
GLOP addressing, multicast IP addresses, 640
Goodbye messages (EIGRP), 236
Graft messages, PIM-DM, 700-702
granted window, 157
gratuitous ARPs, 759
Group Destination Address (GDA), 664
group radius, 750
group tacacs+, 750
groups of AAA servers, 750-751
group-specific query messages, IGMPv2, 654-656

half duplex (HDX), 9
hardware for SWAN, 831
hardware queues, 519
hashed enable passwords, 748
HDLC (High-Level Data Link Control), 595-596
HDX (half duplex), 9
header compression, PPP, 602-603
header fields, Ethernet, 15
header format for IP addresses, 126-128
headers
  Frame Relay, 612-613
  LSA headers, 265
  TCP, 159
Hello, 308
hello intervals (EIGRP), 234
hello messages
  discovering neighbors, 263-264
  forming adjacencies with PIM hello messages, 691
hellos, EIGRP, 233-236
help
  CLI help features, 860-861
  IOS commands, 861
hexadecimal values, converting to decimal and binary values, 955, 959
High-Level Data Link Control (HDLC), 595-596
HLEN (Offset), 160
hold-queue command, 527
hold-queue limit, 526
hold-queue x out, 521
home wireless LANs, 842-844
host membership query functions, IGMPv1, 646-647
host membership report functions, IGMPv1, 647-648
  solicited host membership report, 648-649
  unsolicited host membership report, 650
host part (classful IP addressing), 94
host part (IP addressing), 97
HSRP (Hot Standby Router Protocol), 141-143
HTTP protocol, TCP/IP, 856

I

IANA (Internet Assigned Numbers Authority), 638
iBGP (internal BGP), 362-365
over eBGP, 466
iBGP routes, adding to IP routing tables, 394-396
BGP synchronization and redistributing routes, 396-398
confederations, 399-401
configuring confederations, 401-404
disabling BGP synchronization, 398
RRs, 404-409
ICMP (Internetwork Control Message Protocol), 134-135
ICMP Redirect message, 137
ICMP Time Exceeded message, 136
ICMP Unreachable message, 135
port numbers, 771
ICMP echo replies, 134
ICMP echo requests, 134
ICMP Redirect message, 137
ICMP Time Exceeded message, 136
ICMP Unreachable message, 135
IDS (intrusion detection system), 829-830
CiscoWorks WLSE, 836
neighbor ID, 468-469
maximum-paths command, 471-472
IEE 802.1D STP Timers, 85
IEE 802.3u, 22
IEEE 802.2, 22
IEEE 802.3, 22
IEEE 802.3ab, 22
IEEE 802.3z, 22
IEEE 802.11, 788
802.11a, 788-789
802.11b, 789-790
802.11g, 790-791
802.11n, 791
ad hoc mode. *See* ad hoc mode
comparing standards, 791
infrastructure mode. *See* infrastructure mode
RF signals. *See* RF signals
wireless configuration parameters, 801
data rates, 804-805
fragmentation, 808
power-save mode, 805-806
RF channels, 803-804
RTS/CTS, 806-808
SSID, 802-803
transmit power, 804
wireless hardware components, 794
access points, 795
antennas, 795-796
bridges, 797
radio cards, 795
radio frequency peripherals, 797
repeaters, 796
routers, 797
wireless medium access, 809-810
wireless security, 810
AES, 812
open system authentication, 812
shared key authentication, 812-813
TKIP, 811
VPNs, 813
WEP, 811
WPA, 812
wireless system configuration, 791
ad hoc mode configuration, 794
infrastructure mode configuration, 792-794
IGMP snooping, 669, 671-673
comparing all versions, 661
managing distribution of multicast traffic, 643-644
joining groups, 644

IGMP (Internet Group Management Protocol), 635, 645
joining groups, 670
RGMP, 674
IGMPv1, 645-646
host membership query functions, 646-647
host membership report functions, 647-648
solicited host membership report, 648-649
unsolicited host membership report, 650
interoperability with IGMPv2, 657-658
leave mechanisms, 651
querier, 651
routers, 658
timers, 659
IGMPv2, 651-653
interoperability with IGMPv1, 657-658
leave groups and group-specific query messages, 654-656
querier, 656
routers, 658
timers, 659
IGMPv3, 659-661
SSM, 640, 660
IGPs (Interior Gateway Protocols), 360
in keyword, 428
Inactivity, 308
inappropriate IP addresses, 774-775
InARP (Frame Relay Inverse ARP), 180-183
disabling, 184-185
inclusive summary routes, 107
binary method, 108-109
decimal method, 109-110
Individual/Group (I/G) bit, 17
Inform message, SNMP, 166
infrastructure mode, 798
connecting with networks, 799
data transfers, 799-800
roaming, 800
scanning, 798-799
wireless LANs, 792-794
infrastructure wireless LAN. *See* infrastructure mode
input events, EIGRP, 241-243
Inside Global addresses, 114
Inside Local addresses, 114
intercept mode, TCP intercept, 776
interface ID (IPv6 global addresses), 121
interface resets, synchronous serial links, 594-595
interfaces, 521
assigning to VLANs, 35
using configuration mode to put interfaces into VLANs, 34-35
versus subinterfaces and virtual circuits, queuing, 520
Interior Gateway Protocol (IGPs), 360
internal BGP. *See* iBGP
internal processing, switches, 23
Internal Spanning Tree (IST), 82
International Organization for Standardization (ISO), 851
Internet Assigned Numbers Authority (IANA), 638
Internet Group Management Protocol. *See* IGMP
Internet Standard Management Framework. *See* SNMP
Internetwork Control Message Protocol. *See* ICMP
internetworks, 96
interoperability, IGMPv1 and IGMPv2, 657-658
intersymbol interference (ISI), 820
intrusion detection system. *See* IDS
Inverse ARP (Frame Relay Inverse ARP), 179-183

IOS
boot system command, 859
command help, 860
commands, 862
queuing, 521
IOS commands, catalyst IOS commands for catalyst switch configuration, 23
IOS software boot sequences, 858-859
IP
ARP, 137-139
BOOTP, 139-141
command reference, 146-148
DHCP, 139-141
GLBP, 141-143
HSRP, 141-143
ICMP, 134-135
ICMP Redirect message, 137
ICMP Time Exceeded message, 136
ICMP Unreachable message, 135
NTP, 143-145
proxy ARP, 137-139
RARP, 139-141
standards documents for, 146
and VLANs, 31
VRRP, 141-143
ip access-group command, 769
IP ACE, port matching, 771
IP ACL (IP access control lists), 769
ACEs, 770-771
command references, 769
wildcard masks, 772
IP addresses, 94-95
CIDR (classless interdomain routing), 111-112
classful logic, 94-95
subnets, 95-96
classless logic, 94, 97
command reference, 126
determining range of
binary method, 98-99
decimal method, 99-101
header format, 126-128
inappropriate IP addresses, 774-775
IPv6, 119-120
address formats, 120
aggregatable global unicast addresses, 120-121
dual stack configuration, 121-123
types of addresses, 123-124
NAT (network address translation), 113-114, 125
dynamic NAT (without PAT), 116-117
dynamic NAT configuration, 118-119
static NAT, 115-116
PAT (Port Address Translation), 117
private addressing, 113
protocol field values, 128
protocols for, 125
route summarization, 107-108
exclusive summary routes (binary method), 110
inclusive summary routes (binary method), 108-109
inclusive summary routes (decimal method), 109-110
standards documents, 125
subnet numbers, determining all
binary method, 102-104
decimal method, 104-105
subnets
allocation, 105-106
size of, 97-98
ip bgp-community new-format command, 474
IP cef global configuration command, 179
ip classless command, 186, 345
IP community lists, matching, 475
ip community-list command, 474, 479

IP forwarding, 177-178
classful routing, 185-186
classless routing, 185-186
command references, 197
fast switching, 178
switching paths, 178-179
IP hosts, 94
IP multicast routing, command references, 732
ip multicast routing, 692
IP multicasting, 629, 632
ip multicast-routing, 708
ip ospf area commands, 295
ip ospf authentication, 301
ip ospf cost, 50, 293-294
ip ospf network, 269
ip pim dense-mode, 692
ip pim rp-address, 720
ip pim sparse-mode, 708
ip pim spt-threshold, 717
ip policy command, 192
IP Precedence (IPP) field, 489-490
IP prefix lists, 321-322
ip proxy-arp, 196
IP routing tables, 392
adding eBGP routes, 392-393
adding iBGP routes, 394-396
BGP synchronization and redistributing routes, 396-398
confederations, 399-401
configuring confederations, 401-404
disabling BGP synchronization, 398
RRs, 404-409
adding multiple BGP routes, 450
backdoor routes, 393-394
clearing EIGRP, 250
IP routing. *See* IP forwarding
IP Source Guard, 763-764
ip summary-address rip, 345
ip verify source command, 764
IPP (IP Precedence) field, 489-490
IPsec, 163
IPv4 addresses. *See* IP addresses
IPv6, 119-120
address formats, 120
aggregatable global unicast addresses, 120-121
dual stack configuration, 121-123
types of addresses, 123-124
ISI (intersymbol interference), 820
ISL, VLAN trunking, 44-45
configuration, 45-46
ISO (International Organization for Standardization), 851
isolated VLANs, 37
IST (Internal Spanning Tree), 82

J–K

J1, 592
join message process, CGMP, 666
Join messages, 699
joining shared trees, PIM-SM, 710-712
joining groups, 635
IGMP, 644
IGMP snooping, 670

K values (EIGRP), 234
keepalive timer, 368
key chains, RIP authentication, 216
key sequences for command edit and recall, 861
keyboard commands, 861
keywords
allow-default, 774
established, 771
ACL, 776
group radius, 750
group tacacs+, 750

in, 428
not-advertise, 344
out, 428
passive, 603
summary-only, 429

L

L3PDU (Layer 3 PDU), 856
LACP (Link Aggregation Control Protocol), 77-78
LAN switch forwarding behavior, 19
LANs (local area networks)
802.11. *See* IEE 802.11
DRs, 266
optimizing, 266-268
wireless LANs. *See* wireless LANs
LAPF (Link Access Procedure for Frame-Mode Bearer Services, 612
launching applications, 635
Layer 2 payload compression, 602
Layer 2 security
private VLANs. *See* private VLANs
switch ports, 752
Layer 3 interfaces, MLS, 188
Layer 3 PDU (L3PDU), 856
Layer 3 protocol, 852
Layer 3 security, 768-769
directed broadcasts, 772-774
established keyword, 776
inappropriate IP addresses, 774-775
IP ACL, 769
ACEs, 770-771
wildcard masks, 772
RFCs, 768
RPF checks, 772-774
smurf attacks, 772-774
TCP intercept, 776-777
TCP SYN flood, 775
Layer 3 switching, 186
layers
OSI models, 851-852, 854
benefits, 854-855
layer interactions, 856-857
TCP/IP, 855
LCP (Link Control Protocol), 596-597
configuration, 597-598
LFI, 600-601
MLP, 598-600
Learning state (Spanning Tree), 68
leave groups, IGMPv2, 654-656
leave mechanism, IGMPv1, 651
leave messages, CGMP, 667
Lempel-Ziv (LZ) compression, 602
Lempel-Ziv Stacker (LZS), 602
LFI (Link Fragmentation and Interleaving), 600
LCP, 600-601
lightweight access points, 833
limited-function IOS, 858
limiting
bandwidth, LLQ, 537
CBWFQ bandwidth, 532-534
line coding, 592
Link Access Procedure for Frame-Mode Bearer Services (LAPF), 612
Link Aggregation Control Protocol (LACP), 77-78
Link Control Protocol. *See* LCP
Link Fragmentation and Interleaving (LFI), 600-601
Link Quality Monitoring (LQM), LCP, 597
link state, 260
link-state advertisements (LSAs), 260
link-state ID (LSID), 278
Link-State Refresh (LSRefresh), 275
Link-State Request (LSR), 265

Linksys WRT55AG dual-band access point, 801
Listening state (Spanning Tree), 68
lists most of the settings that impact show ip bgp command, 454
little-endian, 17
LLC (Logical Link Control), 14
LLQ (low-latency queuing), 521, 529, 534-536, 538
bandwidth, 537
FRTS configuration, 569-570
priority queues, 538
tuning shaping for voice, 561-564
LMI (Local Management Interface), 611-612
load balancing
EIGRP, 249
PortChannels, 76
local computation, EIGRP, 241-243
Local Management Interface (LMI), 611-612
LOCAL_PREF, 457-458
LOCAL_PREF PA, 447
LOF (Loss of Frame), 594
log-adjacency-changes detail, 292
logic
discarding, 540
MLS logic, 186
Logical Link Control (LLC), 14
login authentication command, 751
login security, overriding defaults for, 751
Loop Guard, 83-84
loop prevention, RIP, 205-206
ceased updates, 210-212
steady-state operation, 206-208
triggered updates and poisoned routes, 208-210
tuning, 212-213
loopback circuitry, NICs, 11
looped link detection, LCP, 597
loop-inconsistent state, 84
LOS (Loss of Signal), 594
Loss of Frame (LOF), 594
low-latency queuing. *See* LLQ
LQM (Link Quality Monitoring), LCP, 597
LSA headers, 265
flooding to neighbors, 264
LSA summary, 287
LSA type 1, 278-281
LSA type 2, 278-281
LSA type 3, 281-284
LSA type 4, 284-285
LSA type 5, 284-285
LSA types and OSPF design, 286-287
lsa-group, 309
LSAs (link-state advertisements), 260
LSID (link-state ID), 278
LSR (Link-State Request), 265
LSRefresh, 308
LSRefresh (Link-State Refresh), 275
LZ (Lempel-Ziv) compression, 602
LZS (Lempel-Ziv Stacker), 602

M

MAC address reduction, 63
MAC addresses
mapping to multicast IP addresses, 642-643
overriding, 18
tables, displaying, 53, 86, 197, 778
Management Information Base (MIB), 163
mandatory PAs, 446
many-to-few multicasts, 632
many-to-many multicasts, 632
map-class frame-relay command, 566
map-class shape-with-LLQ, 620

mapping multicast IP addresses to MAC addresses, 642-643
mark probability denominator (MPD), 540
marking tools. *See* classification and marking tools
masks
classful IP addressing, 94
wildcard masks, 424
match as-path list-number command, 439
match command, 319-320
match commands (MQC), 498-499, 511-512
match ip address command, 192
match length command, 192
MaxAge, 308
maximum segment size (MSS), 158
maximum-paths command, 450, 470, 472
BGP decision process tiebreakers, 466-467
max-metric router-lsa on-startup announce-time command, 304
max-metric router-lsa on-startup wait-for-bgp command, 304
max-reserved-bandwidth, 532
MBGP (Multiprotocol Border Gateway Protocol), 687
Measured Round-Trip Time (MRTT), 157
MED (MULTI_EXIT_DISC), 464
configuring
multiple adjacent autonomous systems, 465-466
single adjacent AS, 465
features of, 464
scope of, 466
memorizing, mnemonics for memorizing BGP decision process, 451-452
messages
Assert messages, PIM, 703-704
CGMP, 668
Graft messages, PIM-DM, 700-702
Join, 699
OSPF messages, 261-262
OSPF messages. *See* OSPF messages
PIM-DM, summary of messages, 705
Prune messages, PIM-DM, 693-695
state refresh messages, PIM-DM, 699-700
metacharacters, 433

metric types
redistribution routes, 340-342
route redistribution, 328-329
metrics
calculating for types 1 and 2, 285-286
redistribution routes, 340-342
route redistribution, 328-329
MIB (Management Information Base), 163
SNMP, 164-166
Microsoft Point-to-Point Compression (MPPC), 602
MIMO (multiple input-multiple output), 791
minimum shaping rate, 559
MIR (minimum information rate), 559
MISTP (Multiple Instance STP), 80
MLD (Multicast Listener Discovery), 662
MLP (Multilink PPP), 597
LCP, 598-600
LFI, 600-601
MLS (multilayer switching), 186
configuring, 188-191
Layer 3 interfaces, 188
logic, 186
routed ports, 187

mnemonics
for memorizing BGP decision process, 451-452
OSI terminology, 855
modified tail drop, 526
modifying queue length, 520
Modular QoS CLI. ***See*** **MQC, 495**
modulation, RF signals, 814
MOSPF (Multicast Open Shortest Path First), 635, 691, 706
MPD (mark probability denominator), 540
MPLS Experimental (EXP) field, 494
MPPC (Microsoft Point-to-Point Compression), 602
MQC (Modular QoS CLI), 495-496
class maps, 497-499
match commands, 511-512
NBAR, 499-500
mroute flags, 735
MRTT (Measured Round-Trip Time), 157
MSDP (Multicast Source Discovery Protocol), 721
Anycast RP, 726-727
MSS (maximum segment size), 158
MST (Multiple Spanning Trees), 80, 82
configuring, 81
MSTP (Multiple STP), 80
mtrie, 179
multicasting, traffic, 635
MULTI_EXIT_DISC (MED), 464
multi-action policing, CB Policing configuration, 578
multicast addresses, 16
multicast applications, 632
multicast Ethernet frames, 16
multicast forwarding using dense mode, 684-685
multicast forwarding using sparse mode, 687-689
multicast IP addresses, 638
GLOP addressing, 640
mapping to MAC addresses, 642-643
permanent multicast groups, 639
private multicast domains, 640
ranges, 641
SSM, 640
transient groups, 639, 641
multicast IP addresses range and structure, 638
Multicast Listener Discovery (MLD), 662
Multicast Open Shortest Path First. ***See*** **MOSPF**
multicast routing, 683-684
dense-mode routing protocols. *See* dense-mode routing protocols
multicast forwarding using dense mode, 684-685
multicast forwarding using sparse mode, 687-689
multicast scoping. *See* multicast scoping
problems, 683
RPF check, 685-687
multicast scoping, 689
administrative scoping, 690
TTL scoping, 689-690
Multicast Source Discovery Protocol. ***See*** **MSDP**
multicasting, 632
broadcast method, 633
requirements for, 635
scaling, 637
traffic, 637
unicast, 632-633
multicasts
CGMP. *See* CGMP
IGMP snooping. *See* IGMP snooping
RGMP. *See* RGMP

multi-exit discriminators, 464
multilayer switching. *See* MLS
Multilink PPP (MLP), 597
multipath, RF signals, 820-821
multiple adjacent AS, 466
multiple input-multiple output (MIMO), 791
Multiple Instance STP (MISTP), 80
Multiple Spanning Trees (MST), 80, 82
configuring, 81
Multiple STP (MSTP), 80
Multiprotocol Border Gateway Protocol (MBGP), 687
mutual redistribution at multiple routers, 333-335

N

naming VLANs, 53, 197
NAT (Network Address Translation), 111, 113-114, 125
dynamic NAT, configuration, 118-119
dynamic NAT (without PAT), 116-117
static NAT, 115-116
NAT overloading. *See* PAT (Port Address Translation)
NBAR (Network-Based Application Recognition), 507
CB Marking tool, 507-508
MQC classification with, 499-500
NBMA (nonbroadcast multi-access) networks, 269
NBMA networks
OSPF network types, 270-272, 274
setting priority on, 272-273
NCP (Network Control Protocol), 596
neighbor command, 270, 274, 468
neighbor default-originate, 382
neighbor ebgp-multihop command, 401, 468
neighbor filter-list command, 439
neighbor ID, 467, 469
maximum-paths command, 471-472
neighbor peer-group command, 365
neighbor remote-as command, 365-366
neighbor route-map command, 439
neighbor shutdown command, 370

neighbor states, 262
OSPF, 309
neighbor weight command, 456
neighbors
advertising BGP routes to, 383
BGP Update message, 383-384
determining contents of updates, 384-386
impact of decision process and NEXT_HOP, 386-391
BGP neighbors. *See* BGP neighbors
discovering, 263-264
EIGRP, 233-236
Network Address Translation. *See* NAT
network backdoor command, 394
network command, 295
injecting prefixes and routes into BGP tables, 370-371, 373
Network Control Protocol (NCP), 596
network layer protocol, 852
Network Layer Protocol ID (NLPID), 612
network layer reachability information (NLRI), 370
network part (classful IP addressing), 94
Network-Based Application Recognition. *See* NBAR
networks, 94, 96
connecting to networks with infrastructure mode, 799
NBMA networks
OSPF network types, 270-272, 274
setting priority on, 272-273

NEXT_HOP, 466
NEXT_HOP PA, 385, 446
NEXT_HOP reachable, 456
next-hop feature, RIP, 219-220
NICs, loopback circuitry, 11
NLPID (Network Layer Protocol ID), 612
NLRI (network layer reachability information), 370
filtering using COMMUNITY values, 479
filtering BGP updates, 424-427
route maps, 427
soft reconfiguration, 428
NLRI filtering tools, 424
no auto-summary command, 370
no frame-relay inverse-arp, 184
no frame-relay inverse-art, 184
no ip classless, 186
no ip classless command, 345
no ip directed-broadcast command, 773
no ip route-cache cef commands, 179
no synchronization command, 395
no terminal editing, 861
nonbroadcast multi-access (NBMA) networks, 269
noncanonical, 17
nonoverlapping channels, IEEE 802.11g, 790
nontransitive, PAs, 446
normal-range VLANs, 42
not-advertise keyword, 344
NTP (Network Time Protocol), 143-145
numeric ranges, OSPF, 310

O

OAM (Operation Administration, and Maintenance), 594
Offset (HLEN), 160
offset lists
EIGRP, 250
RIP, 220-222
OOF (Out of Frame), 594
open system authentication, 811-812
Open System Interconnection reference model. *See* OSI models
Operation, Administration, and Maintenance (OAM), 594
optimizing
DRs on LANs, 266-268
STP, 73
BackboneFast, 73, 75
discovery and configuration of PortChannels, 77-78
load balancing PortChannels, 76
PortChannels, 76
PortFast, 73-75
UplinkFast, 73-75
Organizationally Unique Identifier (OUI), 17
ORIGIN, BGP tables, 382-383
ORIGIN PA, 458, 463
orthogonal frequency division multiplexing, RF signals, 818

OS categories four routers, 858
OSI (Open System Interconnection) models, 851
OSI models, 851
layer interactions, 856-857
layers, 851-852, 854
benefits, 854-855
terminology, 855-856
OSPF (Open Shortest Path First)
command references, 305-307
configuring, 290-292
alternatives to OSPF network command, 295
authentication, 301-303
costs, 292-295

stub router, 303-304
virtual links, 299-301
costs, 292-295
DRs on LANs, 266
election on, 268-269
optimizing, 266-268
filtering, 295
ABR LSA type 3 filtering, 297-299
distribute-list command, 295-297
neighbor states, 309
numeric ranges, 310
processes, clearing, 292-295
RIDs, 260-261
SPF calculation, 274-275
steady-state operation, 275
stubby areas, 287-290
ABRs, 287
OSPF ABR LSA type 3 filtering, 297-298
area range command, 299
ospf auto-cost reference-bandwidth, 294
OSPF database exchange, 260
IP protocol 89, 261
RIDs, 260-261
OSPF design, 276-277
and LSA types, 286-287
OSPF LSA types, 277-278
and OSPF design, 286-287
types 1 and 2, 278-281
types 3, 281-284
types 4 and 5, 284-285
OSPF messages, 261-262
DD messages, flooding LSA headers to neighbors, 264
hello messages, discovering neighbors, 263-264
LSA headers, 265
OSPF network types, 269
NBMA networks, 270-272, 274
OSPF route summarization, 344
OSPF timer, 308
OSPF wait time, 268
OUI (Organizationally Unique Identifier), 17
out keyword, 428
Out of Frame (OOF), 594
outgoing interface lists, 694
Outside Global addresses, 114
Outside Local addresses, 114
overriding
defaults for login security, 751
MAC addresses, 18

P

Packet Description Language Modules (PDLMs), 508
packet routing
ARP, 137-139
BOOTP, 139-141
classification and marking tools. *See* classification and marking tools
command references, 146-148
DHCP, 139-141
EIGRP, 233
adjacencies, 233-236
authentication, 250
autosummarization, 250
clearing IP routing tables, 250
command reference, 251-252
configuration, 246-249
convergence, 240-246
load balancing, 249
offset lists, 250
packet types, 252
route filtering, 250
split horizon, 250
topology table, 238-240
updates, 236-238
GLBP, 141-143
HSRP, 141-143

ICMP, 134-135
ICMP Redirect message, 137
ICMP Time Exceeded message, 136
ICMP Unreachable message, 135
NTP, 143-145
proxy ARP, 137-139
RARP, 139-141
RIP, 204-205
authentication, 216-219
command reference, 225-226
configuration, 213-216
convergence and loop prevention, 205-213
distribution list and prefix list filtering, 222-224
next-hop and split horizon features, 219-220
offset lists, 220-222
standards documents, 225
standards documents for, 146
VRRP, 141-143
packets
conforming packets, 571
Ethernet, 14
exceeding packets, 571
queuing, 521
violating packets, 571
PAgP (Port Aggregation Protocol), 77-78
parameters, FRTS configuration, 568-569
PAs (path attributes), 360
BGP, 410
NEXT_HOP, 385
ORIGIN, BGP, 382-383
ORIGIN PA, 458-459, 463
passive, 603
passive mode, FTP, 161-162
passive scanning, infrastructure mode, 798
password command, 745
passwords
CLI, 745-746
enable and username passwords, 746-747
hashed/encrypted enable passwords, 748
PAT (Port Address Translation), 117
configuration, 118-119
path attributes. *See* PAs
path vector logic, 360
payload compression, Frame Relay, 619-620
PCF (point coordination function), 809
PCM (pulse code modulation), 592
PDLMs (Packet Description Language Modules), 508
PDU (protocol data unit), 856
peak information rate (PIR), 573
peak rates, CB Shaping, 565
Per VLAN Spanning Tree Plus (PVST+), 68-70
percentages, CB Policing configuration, 578-579
Per-Hop Behaviors. *See* PHBs
permanent multicast groups, multicast IP addresses, 639
permit .*, 442
phase shift keying (PSK), 815
PHBs (Per-Hop Behaviors), 490
Assured Forwarding (AF) PHBs, 491-492
Class Selector (CS) PHBs, 491
Expedited Forwarding (EF) PHBs, 492-493
PIM (Protocol Independent Multicast), 687
bidirectional PIM, 729-730
sparse-dense mode, 723

PIM-DM (Protocol Independent Multicast dense mode), 635-636, 638, 690-691
Assert messages, 703-704
designated routers, 704
forming adjacencies with PIM hello messages, 691
Graft messages, 700-702
Prune messages, 693-695
Prune Override, 702-703
reacting to failed links, 695-697
rules for pruning, 697-699
source-based distribution trees, 692-693
steady-state operation and state refresh messages, 699-700
summary of messages, 705
versus PIM-SM, 707, 730
PIM-SM (Protocol Independent Multicast Sparse Mode), 635, 689, 707
Assert messages, 703-704
designated routers, 704
finding RPs, 720
Anycast RP with MSDP, 726-727
Auto-RP, 721-723
BSR, 724-725
joining shared trees, 710-712
Prune Override, 702-703
pruning shared trees, 719-720
RPs multicast routing tables, 716-717
shared distribution trees, 714
shortest-path tree switchovers, 717-719
source registration process, 712, 714
sources sending packets to RP, 708-710
steady-state operations by continuing to send joins, 715-716
versus PIM-DM, 707, 730
ping packets, 134
PIR (peak information rate), 573
point coordination function (PCF), 809
Point-to-Point Protocol. *See* PPP
poisoned routes (RIP), 208-210
police command, 575, 577-578
policers, 509-510
policies, BGP routing policies. *See* BGP routing policies
policing
CB Policing. *See* CB Policing
single-rate, three-color policing, 573
single-rate, two-color policing, 571-572
subsets of traffic, CB Policing, 576-577
two-rate, three-color policing, 573-575
policy maps, 564
policy routing, 191, 193-196, 510
set commands, 192
policy-map command (MQC), 496
policy-map queue-voip, 563
poll interval, 308
Port Address Translation. *See* PAT
Port Aggregation Protocol (PAgP), 77-78
port matching, IP ACE, 771
port numbers, TCP, 155-156
port security configuration commands, 755
PortChannels, optimizing STP, 76
discovery and configuration, 77-78
load balancing, 76
PortFast, optimizing STP, 73-75
ports, 61
access ports, protecting, 82-83
designated ports, 64-65
root ports, 63-64
routed ports, MLS, 187
switch ports, 752
switches, assigning to VLANs, 53
trusted ports, 752
unused ports, 752
best practices for, 753-754
unused ports. *See* unused ports
user ports. *See* user ports

POST (power-on self-test), 858
power-save mode, wireless configuration parameters (IEEE 802.11), 805-806
PPP (Point-to-Point Protocol), 595-596
compression, 601-602
header compression, 602-603
layer 2 payload compression, 602
LCP, 596-597
configuration, 597-598
LFI, 600-601
MLP, 598-600
security, 752
ppp authentication, 752
ppp multilink fragment-delay commands, 601
ppp multilink interleave command, 600
PQ (priority queuing), 522
prefix length, 97
prefix list filtering, RIP, 222-224
prefix lists versus route maps and distribute lists (BGP), 428-429
prefix part (IP addressing), 97
prefixes, 94, 97
injecting into BGP tables, 370
network command, 370-371, 373
redistributing from IGP, static, or connected routes, 373-375
prefix-list commands, 322
BGP, 425
prepending AS_PATH, 461, 463
preventing
suboptimal routes by setting the AD, 335-338
suboptimal routes by using route tags, 338-340
primary subnets, 234
primary VLANs, 37
priority command, 529, 535
priority queuing (PQ), 522
priority-queue out command, 543
privacy, TCP/IP, 163
private IP addressing, 113
private multicast domains, multicast IP addresses, 640
private VLANs, 36-38, 767-768
process switching, IP forwarding, 179
protecting
access ports, 82-83
STP, 82
BPDU Guard, 82-83
Loop Guard, 83-84
Root Guard, 82-83
UDLD, 83-84
trunks, 83-84
protocol data unit (PDU), 856
protocol field values, IP addressing, 128
Protocol Independent Multicast (PIM), 687
Protocol Independent Multicast Dense Mode.
***See* PIM-DM**
Protocol Independent Multicast-Sparse Mode. *See* PIM-SM
Protocol Type fields. *See* Type fields
protocols
application protocols, TCP/IP, 160-161
ARP, 137-139
BOOTP, 139-141
DHCP, 139-141
EIGRP, 233
adjacencies, 233-236
authentication, 250
autosummarization, 250
clearing IP routing tables, 250
command reference, 251-252
configuration, 246-249
convergence, 240-246
load balancing, 249
offset lists, 250
packet types, 252
route filtering, 250
split horizon, 250

topology table, 238-240
updates, 236-238
GLBP, 141-143
HSRP, 141-143
ICMP, 134-135
ICMP Redirect message, 137
ICMP Time Exceeded message, 136
ICMP Unreachable message, 135
IGMP, 635
IGPs, 360
for IP addresses, 125
MLD, 662
NTP, 143-145
packet routing, standards documents for, 146
PPP. *See* PPP
proxy ARP, 137-139
RARP, 139-141
RIP, 204-205
authentication, 216-219
command reference, 225-226
configuration, 213-216
convergence and loop prevention, 205-213
distribution list and prefix list filtering, 222-224
next-hop and split horizon features, 219-220
offset lists, 220-222
standards documents, 225
RTP, 236
SNMP, 164-166
TCP. *See* TCP
UDP, 154-155
VRRP, 141-143
proxy ARP, 137-139
Prune messages, PIM-DM, 693-695
Prune Override, PIM, 702-703
pruning
PIM-DM, 697-699
shared trees, PIM-SM, 719-720
pseudonodes, 279
PSH (Push), 160
PSK (phase shift keying), 815
public wireless LANs, 840-842
pulse code modulation (PCM), 592
PVST+ (Per VLAN Spanning Tree Plus), 68-70

Q

QAM (quandrature amplitude modulation), 815, 818
QoS service classes, 496
QoS tools, classification and marking. ***See*** **classification and marking tools**
quartets, IPv6 addresses, 120
querier
IGMPv1, 651
IGMPv2, 656
Query Response Interval, 649
query scope (EIGRP), limiting, 246
queue lengths
modifying, 520
WFQ, 526-527
queuing, 515, 521
Cisco 3550, 545-546
Cisco 3550 switches, egress queuing, 543-545
discard categories, WRED, 539
hardware queues, 519
interfaces versus subinterfaces and virtual circuits, 520
protocol comparison, 538
software queues, 519
WRED
configuration, 542
weight packets, 541

queuing tools
CBWFQ, 529-530, 532, 538
bandwidth, 532-534
command references, 530
comparing, 520
CQ, 523-524
FIFO queuing, 521
LLQ, 529, 534-536, 538
bandwidth, 537
more than one priority queue, 538
PQ, 522
WFQ, 524-525
configuration, 527-528
drop policy, number of queues, and queue lengths, 526-527
types of queues, 527
WFQ scheduler, 525-526
queue-voip, 569

R

R2, 407
R2# sh ip bgp | include 10.1.34.4, 444
R2# show ip bgp neighbor 3.3.3.3 received-routes | include 303, 443
R3, 407
R9, 407
radio cards, 795
radio frequency peripherals, 797
radio management aggregation, 828
RADIUS, 747
configuring server groups, 750
RADIUS attribute, 764
radius-server host, 750
ranges, multicast addresses, 641
Rapid Spanning Tree Protocol (RSTP), 78-80
RARP, 139-141
RAT (Router Audit Tool), 775
rate-limit ACL, 580
rate-limit command, 579
RD (reported distance), 239
reacting to failed links, PIM-DM, 695-697
reassociation, 793
receiver's advertised window, 157
receiver's window, 157
Red alarm, 594
redistribute command, 321, 324-325
redistribute connected command, 458
redistribute ospf commands, 328
redistribute static, 347-348
redistributing
from IGP, static, or connected routes, BGP tables, 373-375
route maps
with match command, 319-320
with set commands, 320
redistribution, 324, 329-333
command references, 352
metrics and metric types, 340-342
mutual redistribution at multiple routers, 333-335
setting metrics, metric types, and tags, 328-329
using default settings, 325-328
refilling dual token buckets, 573
regular expressions, matching AS_PATH, 433-434
relay agents (DHCP), 140
Reliable Transport Protocol (RTP), 236
Remote Monitoring MIB, 166
removing
COMMUNITY values, 475, 479
private ASNs, 460-461
rendezvous point (RP), 687
repeaters, 796
reported distance (RD), 239
requesting LSA headers, 265

request-to-send/clear-to-send. ***See*** **RTS/CTS**
Resource Reservation Protocol (RSVP), 527
Retransmission, 308
reverse-path-forwarding (RPF) paths, 684
revision numbers, VTP, 39-40
RF channels, wireless configuration parameters (IEEE 802.11), 803-804
RF interference, RF signals, 819-820
RF signals, 814
characteristics, 815-816
FCC rules, 819
gain, 816
modulation, 814
multipath, 820-821
orthogonal frequency division multiplexing, 818
RF interference, 819-820
SNR, 816-817
spread spectrum, 817-818
RFCs
DiffServ, 512
Layer 3 security, 768
RGMP (Router-Port Group Management Protocol), 663, 673-675
IGMP snooping, 674
RIB (BGP Routing Information Base), 370
RID (router identifier), 260
RIP (Routing Information Protocol), 204-205
command references, 225-226
configuration, 213-214
authentication, 216-219
autosummarization, 214-216
distribution list and prefix list filtering, 222-224
next-hop and split horizon features, 219-220
offset lists, 220-222
convergence and loop prevention, 205-206
ceased updates, 210-212
steady-state operation, 206-208
triggered updates and poisoned routes, 208-210
tuning, 212-213
standards documents, 225
RIP route summarization, 345
RJ-45 pinouts, 8-9
roaming, infrastructure mode, 800
ROMMON, 858
Root Guard, 82-83
enabling, 754
root port (RP), 63-64
root switches, electing, 61-63
root-path tree (RPT), 710
route aggregation, AS_PATH, 461, 463
route cache, 178
route default routes. ***See*** **default routes**
route filtering, EIGRP, 250
route maps
configuring with route-map command, 317-319
deny clauses, 333
match and set commands for BGP, 479
match commands for route redistribution, 319-320
NLRI filtering, 427
policy routing, 510
versus prefix lists and distribute lists (BGP), 428-429
redistributing subsets of routes, 329-333
set commands for route redistribution, 320

route redistribution, 324
influencing with metrics and metric types, 340-342
redistribute command, 324-325
setting metrics, metric types, and tags, 328-329
using default settings, 325-328
using route maps, 329-333
route reflectors. *See* RRs
route summarization, 107-108, 342-343
creating default routes, 350-351
EIGRP route summarization, 344
exclusive summary routes, binary method, 110
inclusive summary routes
binary method, 108-109
decimal method, 109-110
OSPF route summarization, 344
RIP route summarization, 345
route tags, preventing suboptimal routes, 338-340
routed ports, MLS, 187
route-map command, 317-319
BGP, 425
Router Audit Tool (RAT), 775
router bgp command, 365, 401
router identifier (RID), 260
Router-Port Group Management Protocol. *See* RGMP
routers
ABRs, 276
BGP router ID of advertising router, 467
configuring VLAN trunking on, 49-51
designated routers, PIM, 704
downstream routers, 697
IGMPv1 and IGMPv2, 658
mutual redistribution at multiple routers, 333-335
OS categories, 858
OSPF router IDs, 260-261
queuing, 521
upstream routers, 697
Wi-Fi, 843
wireless LAN routers, 797
routes
backdoor routes, IP routing tables, 393-394
BGP. *See* BGP
default routes, 345-346
adding to BGP, 381-382
injecting into BGP tables, 370
impact of auto-summary on redistributed routes and, 375-377
manual summaries and AS_PATHs, 378-381
network command, 370-371, 373
redistributing from IGP, static, or connected routes, 373-375
ORIGIN, BGP tables, 382-383
preventing suboptimal routes by setting AD, 335-338
preventing suboptimal routes by using route tags, 338-340
static routes, redistribute static, 347-348
routing
classful routing, 185-186
classless routing, 185-186
policy routing, 191, 193-196
set commands, 192
Routing Information Protocol. *See* RIP
routing packets. *See* packet routing

RP (rendezvous point), 687
finding, 720, 728
Anycast RP with MSDP, 726-727
with Auto-RP, 721-723
with BSR, 724-725
multicast routing tables, PIM-SM, 716-717
sources sending packets to, PIM-SM, 708-710
RP (root port), 63
RPF (reverse-path-forwarding) paths, 684
RPF checks, 772-774
multicast routing, 685-687
RPT (root-path tree), 710
RRs (route reflectors), 404
IP routing tables, 404-409
RSTP (Rapid Spanning Tree Protocol), 78-80
RSVP (Resource Reservation Protocol), 527
RTP (Reliable Transport Protocol), 236
RTS/CTS (request-to-send/clear-to-send), 806
wireless configuration parameters, IEEE 802.11, 806-808

S

same-layer interaction, 857
SAP (Service Advertising Protocol), 644
scaling, multicasting, 637
scanning, infrastructure mode, 798
active scanning, 799
passive scanning, 798
scheduling
CQ logic, 523
PQ logic, 522
strict-priority scheduling, 547
schemes, queuing, 521
scoping, multicast scoping. ***See*** **multicast scoping**
SDP (Session Description Protocol), 644
secondary VLANs, 37
Secure Shell (SSH), 163, 768
Secure Sockets Layer (SSL), 163
secure user interfaces, CiscoWorks WLSE, 836
security
AAA, 747
authentication methods, 748-750
groups of AAA servers, 750-751
overriding defaults for login security, 751
enterprise security, 837-838
Layer 2 security, switch ports. *See* switch ports
Layer 3 security, 768-769
Layer 3 security. *See* Layer 3 security
passwords. *See* passwords
port security, 754-758
PPP, 752
sniffer traces, 40
SNMP, 164, 167
switches. *See* switch ports
TCP/IP, 163
wireless security. *See* wireless security
security policy monitoring, CiscoWorks WLSE, 836
self-healing functions, CiscoWorks WLSE, 837
sequence number (SN), 525
serial cable control pin leads, 595
servers, groups of AAA servers, 750-751
Service Advertising Protocol (SAP), 644
service password-encryption, 303, 746-747
service set identifier (SSID), 799
service-policy command, 532
service-policy command (MQC), 496

service-policy out command, 538
service-policy output, 532, 559
service-policy output policy-map-name, 564
Session Description Protocol (SDP), 644
set as-path prepend command, 461
set commands, 320
policy routing, 192
set community none command, 475
set fr-de command, 615
SF (Superframe), 592
shape average, 565
shape command, 559, 561
shape fecn-adapt command, 614
shape peak mean-rate command, 565
shape percent command, 564
shaped rate, 556
shaping. *See also* traffic shaping
adaptive shaping, 565
adaptive shaping, FRTS, 570
CB Shaping, 551
configuring by bandwidth percent, 564
FRTS, 551
tuning shaping for voice using LLQ and Tc, 561-564
shaping queues, 555
shaping rate, 556-557
minimum shaping rate, 559
shared distribution trees, PIM-SM, 714
shared key authentication, 811-813
shared trees
creating, 711
joining with PIM-SM, 710-712
pruning, PIM-SM, 719-720
Shortest Path First (SPF), 265
shortest-path tree (SPT), 692
shortest-path tree switchovers, PIM-SM, 717-719
show command, WFQ, 528
show interface trunk command, 48
show interfaces command, 595
show ip arp command, 195
show ip bgp command, 382, 439, 453, 455
show ip bgp neighbor advertised-routes command, 388
show ip bgp neighbor neighbor-id advertised-routes command, 439
show ip bgp neighbor neighbor-id received routes, 439
show ip bgp regexp expression command, 439
show ip command, 23
show ip mroute, 714
show ip mroute command, 692
show ip ospf border-routers, 283
show ip ospf database command, 281
show ip ospf database summary link-id command, 283
show ip ospf neighbor command, 262
show ip ospf statistics command, 283
show ip route command, 290
show queue command, 528
signal-to-noise ratio (SNR), 816-817
Simple Network Management Protocol. *See* SNMP
single adjacent AS, 465
single-bucket, two-color policing, 572
single-rate, three color policing, CB Policing configuration, 575-576
single-rate, three-color policing, 573
single-rate, two-color policing, 571-572
sliding windows, TCP, 157-159
Slow Start Threshold (SSThresh), 159
SLSM (Static Length Subnet Masking), 104
small office wireless LANs, 842-844
smurf attacks, 772-774
SN (sequence number), 525
SNAP (Sub-Network Access Protocol), 14
sniffer traces, 40

SNMP (Simple Network Management Protocol), 163
Get message, 166
Inform message, 166
MIBs, 164, 166
protocol messages, 165-166
protocols, 164
Response message, 166
security, 167
security and administration, 164
Set command, 166
versions, 164
SNMP Traps, 166
SNR (signal-to-noise ratio), 816
RF signals, 816-817
soft reconfiguration, NLRI filtering, 428
software queues, 519
solicited host membership report, IGMPv1, 648-649
source registration process, PIM-SM, 712, 714
source-based distribution trees, PIM-DM, 692-693
Source-Specific Multicast (SSM), 638
Spanning Tree Protocol. ***See*** **STP**
spanning-tree portfast command, 79
spanning-tree vlan command, 73
sparse mode multicast forwarding, 687-689
sparse-dense mode, PIM, 723
sparse-mode routing protocols, PIM-SM, 707
joining shared trees, 710-712
pruning shared trees, 719-720
RP's multicast routing tables, 716-717
shared distribution trees, 714
shortest-path tree switchovers, 717-719
source registration process, 712, 714
sources sending packets to RP, 708-710
steady-state operations by continuing to send, 715-716
versus PIM-DM, 707
speed, Ethernet, 9
SPF (Shortest Path First), 265
SPF calculation, OSPF, 274-275
split horizon
EIGRP, 250
RIP, 219-220
spread spectrum, RF signals, 817-818
SPT (shortest-path tree), 692
SSH (Secure Shell), 163, 768
SSID (service set identifier), 799
CiscoWorks WLSE, 835
wireless configuration parameters, IEEE 802.11, 802-803
SSL (Secure Sockets Layer), 163
SSM (Source-Specific Multicast), 638
IGMPv3, 660
multicast IP addresses, 640
SSThresh (Slow Start Threshold), 159
standards documents
for IP addressing, 125
for packet routing protocols, 146
RIP, 225
state refresh messages, PIM-DM, 699-700
static clients (NTP), 144
static configuration, Frame Relay mapping, 183-184
Static Length Subnet Masking (SLSM), 104
static NAT, 115-116
static routes, redistribute static, 347-348
steady-state operation, 275
by continuing to send joins, PIM-SM, 715-716
steady-state operation (RIP), 206-208
store-and-forward, switches, 23

storing VLAN configurations, 43-44
STP (Spanning Tree Protocol), 57, 61
calculating costs to determine RPs, 63
choosing which ports forward, 61
determining designated ports, 64-65
determining root ports, 63-64
electing root switches, 61-63
command references, 86
configuring, 70-73
converging to STP topology, 65-66
optimizing, 73
BackboneFast, 73, 75
discovery and configuration of PortChannels, 77-78
load balancing PortChannels, 76
PortChannels, 76
PortFast, 73-75
UplinkFast, 73-75
protecting, 82
BPDU Guard, 82-83
Loop Guard, 83-84
Root Guard, 82-83
UDLD, 83-84
topology change notification and updating the CAM, 66-67
transitioning from blocking to forwarding, 67-68
STP forwarding, 61
stratum level (NTP), 144
strict-priority scheduling, 547
Structured Wireless-Aware Network. *See* SWAN
stub network, OSPF LSA types, 278
stub router
configuring OSPF, 303-304
EIGRP, 246-248
stubby areas, OSPF, 287-290
ABRs, 287
stuck-in-active state (EIGRP), 245-246
sub-AS, 399
subinterfaces, queuing, 520
subnet broadcast address, 98
subnet ID field (IPv6 global addresses), 121
subnet numbers
determining
binary method, 98-99
decimal method, 99-101
determining all
binary method, 102-104
decimal method, 104-105
subnets, 94, 97
allocation, 105-106
classful IP addressing, 95-96
primary subnet, 234
route summarization, 107-108
exclusive summary routes (binary method), 110
inclusive summary routes (binary method), 108-109
inclusive summary routes (decimal method), 109-110
size of, 97-98
subnets of traffic, CB Policing, 576-577
Sub-Network Access Protocol (SNAP), 14
successor routes, 240
summaries
LSAs, 287
manual summaries and AS_PATHs (BGP tables), 378-381
summarization. *See also* route summarization
BGP, 429-430
summary-address command, 344
summary-only keyword, 429
Superframe (SF), 592
supernetting, 113
SVIs (switched virtual interfaces), 186

SWAN (Structured Wireless-Aware Network), 828
CiscoWorks WLS
Air/RF scanning and monitoring, 836
assisted site surveys, 835
automatic access point configuration, 834
centralized firmware updates, 835
customizable thresholds, 835
dynamic grouping, 835
fault status, 836
IDS, 836
secure user interfaces, 836
security policy monitoring, 836
self-healing functions, 837
SSIDs, 835
troubleshooting, 837
VLAN configuration, 835
CiscoWorks WLSE, 834
hardware, 831
IDS, 829-830
WDS, 828-829
wireless LAN hardware, 832-834
switch buffering, Ethernet, 10-11
switch ports, 752-753
best practices for unused and user ports, 753-754
802.1X authentication using EAP, 764-766
DAI, 758-761
DHCP snooping, 761-762
IP Source Guard, 763-764
port security, 754-758
switched virtual interfaces (SVIs), 186
switches, 19, 22
command output showing MAC address table, 19, 21
cut-through, 23
Ethernet, 9
fragment-free switches, 23
internal processing, 23
LAN switch forwarding behavior, 19
ports, assigning to VLANs, 53
root switches, electing, 61-63
store-and-forward, 23
switch port configuration, 12-14
unicast forwarding, 19
VLANs, 31
switching, Layer 3 switching, 186
switching paths, 178
IP forwarding, 179
switchport access vlan command, 38, 43
switchport mode command, 49
switchport nonegotiate interface command, 49
switchport port-security maximum command, 756
switchport trunk allowed command, 48
switchport trunk encapsulation command, 49
symmetric active mode (NTP), 144
SYN flag, 156
synchronous serial links, 592
carrier detect and interface resets, 594-595
command references, 604
T1 alarms, 594
T1 framing and encoding, 592-593
System ID Extension, 62

T

T1, 592
alarms, 594
versus E1, 593
framing, 592-593
tables
adjacency tables, 179
ARP and inverse ARP, 179-180
BGP tables. *See* BGP tables

IP routing tables. *See* IP routing tables
TACACS+, 747
tacacs-server host commands, 750
tags, route redistribution, 328-329
Tc, 555-556
tuning shaping for voice, 561-564
TCN (Topology Change Notification), 67
TCP (Transmission Control Protocol), 154
connections and port numbers, 155-156
error recovery, 157
flags, 156
headers, 159
sliding windows, 157-159
versus UDP, 154-155
TCP Congestion Avoidance logic, 158
TCP Congestion Control, 158
TCP intercept, 776-777
TCP SYN flood, 775
TCP/IP
application authentication and privacy, 163
application protocols, 160-161
FTP, passive and active mode, 161-162
HTTP protocol, 856
layers, 855
models, 851
UDP, functions of, 154
TDM (time-division multiplexing), 592
telcos, 592
Temporal Key Integrity Protocol (TKIP), 810-811
terminal editing, 861
terminal history size command, 860
terminology, traffic shaping, 555-556
thresholds, discarding logic, 540
tiebreakers, BGP decision process, 449-450
TIM (traffic indication map), 805
time synchronization, NTP, 143-145
time-division multiplexing (TDM), 592
timers, IGMPv1 and IGMPv2, 659
TKIP (Temporal Key Integrity Protocol), 810-811
token bucket model, 558
tools
BGP filtering tools. *See* BGP filtering tools
NLRI filtering tools, 424
Topology Change Notification (TCN), 67
topology table, EIGRP, 238-240
traffic, multicast traffic, 635, 637
IGMP. *See* IGMP
traffic contracts, 509
traffic indication map (TIM), 805
traffic policers, 551
traffic profiles, WRED, 541
traffic rates, 509
traffic shaping, 555. *See also* shaping
CB Shaping. *See* CB Shaping
egress blocking, 555
Frame Relay, 559
mechanics of, 557-558
shaping rate, 556
terminology, 555-556
with Be, 557
traffic-rate command, FRTS configuration, 567-568
traffic-shape fecn-adapt command, 614
transient groups, multicast IP addresses, 639, 641
transient multicast addresses. *See* transient groups
transit network, OSPF LSA types, 278
transitioning from blocking to forwarding, STP, 67-68
transitive, PAs, 446
Transmission Control Protocol. *See* TCP, 154
transmit power, wireless configuration parameters (IEEE 802.11), 804
transmit queue, 519

Transport Layer Security (TLS), 163
triggered extensions to RIP, 210
triggered updates (RIP), 208-210
troubleshooting CiscoWorks WLSE, 837
trunk configuration compatibility, 48-49
trunk ports, 752
trunking, VLAN trunking, 44
802.1Q, 44-45
ISL, 44-45
ISL configuration, 45-46
trunks
configuration, 53, 779
native VLANs, 766
protecting, 83-84
trusted ports, 752
TTL scoping, 689-690
tuning RIP convergence, 212-213
tunneling, 802.1Q-in-Q, 51-52
twisted pairs, 8
Ethernet, 9
two-rate, three-color policing, 573-575
TX queue, 519
type fields, 18
802.2 LLC, 18
Ethernet, 18

U

UDLD, 83-84
UDLD (UniDirectional Link Detection), 83
UDLD aggressive mode, 83
UDP (User Datagram Protocol), 154
functions of, 154
versus TCP, 154-155
unicast, 632-633
multicast routing, 683
unicast addresses, 16
unicast forwarding, switches, 19
Unicast Source Address (USA), 664
UniDirectional Link Detection (UDLD), 83
Universal/Local (U/L) bit, 17
unsolicited host membership report, IGMPv1, 650
unused ports, 752
best practices for, 753-754
802.1X authentication using EAP, 764-766
DAI, 758-761
DHCP snooping, 761-762
IP Source Guard, 763-764
port security, 754-758
updates
CAM, 66-67
EIGRP, 236-238
UplinkFast, optimizing STP, 73-75
upstream routers, 697
URG (Urgent), 160
Urgent Pointer, 160
USA (Unicast Source Address), 664
User Datagram Protocol. *See* UDP
user mode CLI password protection, 746
user ports, best practices for, 753-754
802.1X authentication using EAP, 764-766
DAI, 758-761
DHCP snooping, 761-762
IP Source Guard, 763-764
port security, 754-758
username commands, 748
username password command, 747
user-priority bits, 493
UTP cabling, 24

V

values, COMMUNITY values, 475, 479
Variable Length Subnet Masking (VLSM), 104
subnet allocation, 105-106
VC (virtual circuit), 610
violating packets, 571
virtual circuits, queuing, 520
virtual LANs. *See* VLANs
virtual links, configuring OSPF, 299-301
Virtual Private Networks (VPNs), 811, 813
Virtual Router Redundancy Protocol (VRRP), 141-143
VLAN configuration, CiscoWorks WLSE, 835
VLAN DAT, 32, 43-44
VLAN database configuration mode, 32-34
VLAN interfaces, MLS logic, 186
VLAN MPLS (VMPLS), 51
VLAN trunking, 44
802.1Q, 44-45
802.1Q configuration, 45-46
allowed and active VLANs, 48
allowed VLANs, 48
configuring on routers, 49-51
ISL, 44-45
configuration, 45-46
trunk configuration compatibility, 48-49
VLAN Trunking Protocol. *See* VTP
VLANs (virtual LANs), 31, 53
active and not pruned, 48
and IP, 31
community VLANs, 37
configuration mode, creating VLANs, 35-36
configuring, 31
VLAN database configuration mode, 32-34
defining, 53, 197
extended-range VLANs, 42
information, displaying, 53, 197, 779
interfaces, assigning, 35
isolated VLANs, 37
layer 2 switches, 31
naming, 53, 197
native VLANs, trunks, 766
normal-range VLANs, 42
primary VLANs, 37
private VLANs, 36-38, 767-768
secondary VLANs, 37
storing configurations, 43-44
trunks, configuration, 53, 779
using configuration mode to put interfaces into VLANs, 34-35
VLSM (Variable Length Subnet Masking), 104
subnet allocation, 105-106
VMPLS (VLAN MPLS), 51
voice, tuning shaping for voice with LLQ and Tc, 561-564
voice services, wireless LANs, 839
VoWLAN (voice over wireless LAN), 839
VPNs (Virtual Private Networks), 811, 813
VRRP (Virtual Router Redundancy Protocol), 141-143
VTP (VLAN Trunking Protocol), 38
configuring, 40-41
extended-range VLANs, 42
normal-range VLANs, 42
revision numbers, 39-40
vty, 751

W

Wait, 308
watch mode, TCP intercept, 776
WC mask (wildcard mask), 424
WCS (Wireless Control System), 833
WDS, 828-829
WDS (Wireless Domain Services), 828
weight packets, WRED, 541
weighted fair queuing. ***See*** **WFQ**
Weighted Random Early Detection (WRED), 539-540
discard categories, 539
WEP (Wired Equivalent Privacy), 799, 810-811
WFQ (weighted fair queuing), 521, 524-525
command references, 527
configuration, 527-528
drop policy, 526-527
number of queues, 526-527
queue lengths, 526-527
show command, 528
types of queues, 527
WFQ scheduler, 524-526
While AS_SET and AS_CONFED_SET, 445
Wi-Fi, 839, 843-844
Wi-Fi Protected Access (WPA), 811-812
wildcard masks, 424
IP ACL, 772
windows
receiver's window, 157
sliding windows, TCP, 157-159
Wired Equivalent Privacy (WEP), 799, 810-811
wireless bridges, 833
wireless configuration parameters, IEEE 802.11, 801
data rates, 804-805
fragmentation, 808
power-save mode, 805-806
RF channels, 803-804
RTS/CTS, 806-808
SSID, 802-803
transmit power, 804
Wireless Control System (WCS), 833
Wireless Domain Services (WDS), 828
wireless hardware components, 802.11, 794
access points, 795
antennas, 795-796
bridges, 797
radio cards, 795
radio frequency peripherals, 797
repeaters, 796
routers, 797
wireless LAN client adapters, 833
wireless LAN controllers, 833
wireless LAN hardware, SWAN, 832-834
wireless LANs
applying in enterprises, 837
security, 837-838
voice services, 839
public wireless LANs, 840-842
small office or home, 842-844
wireless medium access, IEEE 802.11, 809-810
wireless security
comparing, 813
IEEE 802.11, 810
AES, 812
open system authentication, 812
shared key authentication, 812-813
TKIP, 811
VPNs, 813
WEP, 811
WPA, 812

wireless system configurations, 802.11, 791
ad hoc mode configuration, 794
infrastructure mode configuration, 792-794
workgroup bridges, 833
WPA (Wi-Fi Protected Access), 811-812
WRED (Weighted Random Early Detection), 539-540
configuration, 542
discard categories, 539
DSCP-based WRED, 541
traffic profiles, 541
weight packets, 541
wrr-queue dscp-map, 546
wrr-queue random-detect, 546

Y–Z

Yellow alarm, 594

zero subnets, 98